WHAT IS CLAIMED IS

1. An acceleration sensor for detecting an acceleration caused by an object oscillated in an oscillation direction, comprising:

a sensor casing having a center axis and to be positioned in coaxial alignment with said oscillation direction to receive said acceleration, said sensor casing including a cylindrical fixed case member having a supporting portion axially extending, and a cover assembly provided on said fixed case member to cover said fixed case member to define a closed space,

an oscillation plate accommodated in said closed space of said sensor casing and having a central portion supported by said supporting portion of said fixed case member, and a peripheral portion integrally formed with said central portion and extending radially outwardly of said central portion to be freely movable with respect to said supporting portion of said fixed case member, and said oscillation plate being partly oscillatable along said center axis with respect to said fixed case member;

a piezoelectric element held in contact with said oscillation plate to generate a voltage indicative of said acceleration when said acceleration is exerted on said sensor casing to have said oscillation plate partly oscillated along said center axis with respect to said sensor casing with said peripheral portion of said oscillation plate being deformed, and said piezoelectric element having first and second surfaces respectively having first and second electrodes mounted thereon to have said voltage indicative of said acceleration to output therethrough;

a terminal pin extending through said cover assembly and terminating at the exterior of said cover assembly, and

a printed board retained by said cover assembly to have said second electrode of said piezoelectric element and said terminal pin connected with each other.

2. An acceleration sensor for detecting an acceleration as set forth in claim 1, in which said fixed case member and said oscillation plate are each made of an electroconductive material to ensure that said first electrode is electrically connected with said oscillation plate and said fixed case member, said cover assembly comprises a metal base member made of an electroconductive material and a cover member made of an insulating material, said metal base member having a peripheral end portion welded to

part of said fixed case member with said closed space defined by said metal base member and said fixed case member, said cover member being mounted on said metal base member with said printed board interposed between said metal base member and said cover member, and said terminal pin extending through said metal base member, said printed board, and said cover member and electrically connected with said second electrode of said piezoelectric element.

3. An acceleration sensor for detecting an acceleration caused by an object oscillated in an oscillation direction, comprising:

a sensor casing having a center axis and to be positioned in coaxial alignment with said oscillation direction to receive said acceleration, said sensor casing including a cylindrical fixed case member having a supporting portion axially extending, and a cover assembly provided on said fixed case member to cover said fixed case member to define a closed space,

an oscillation plate accommodated in said closed space of said sensor casing and having a central portion supported by said supporting portion of said fixed case member, and a peripheral portion integrally formed with said central portion and extending radially outwardly of said central portion to be freely movable with respect to said supporting portion of said fixed case member, and said oscillation plate being partly oscillatable along said center axis with respect to said fixed case member;

a piezoelectric element held in contact with said oscillation plate to generate a voltage indicative of said acceleration when said acceleration is exerted on said sensor casing to have said oscillation plate partly oscillated along said center axis with respect to said sensor casing with said peripheral portion of said oscillation plate being deformed, and said piezoelectric element having first and second surfaces respectively having first and second electrodes mounted thereon to have said voltage indicative of said acceleration to output therethrough;

first and second terminal pins extending through said cover assembly and terminating at the exterior of said cover assembly, and

a printed board retained by said cover assembly to have said electrodes of said piezoelectric element and said terminal pins connected with each other.

4. An acceleration sensor for detecting an acceleration as set forth in claim 3, in which said fixed case member and said oscillation plate are each made of an

electroconductive material to ensure that said first electrode is electrically connected with said oscillation plate and said fixed case member, said cover assembly comprises a metal base member made of an electroconductive material and a cover member made of an insulating material, said metal base member having a peripheral end portion welded to part of said fixed case member with said closed space defined by said metal base member and said fixed case member, said cover member being mounted on said metal base member with said printed board interposed between said metal base member and said cover member, said first terminal pin extending through said metal base member, said printed board and said cover member to be electrically connected with said first electrode of said piezoelectric element by way of said fixed case member, said metal base member and said printed board, and said second terminal pin extending through said metal base member, said printed board and said cover member to be electrically connected directly with said second electrode of said piezoelectric element.

5. An acceleration sensor for detecting an acceleration as set forth in any one of claims 1 through 4, in which said metal base member is formed with a central hole, and said terminal pin having a contacting rod portion projecting from said printed board and extending through said central hole of said metal base member to project into said closed space in electrical connection with said second electrode of said piezoelectric element.

6. An acceleration sensor for detecting an acceleration as set forth in any of claim 1 through claim 5, in which said printed board has a signal processing circuit.

7. An acceleration sensor for detecting an acceleration as set forth in any one of claims 1 through 6, in which said cover member has a first surface firmly held in contact with said metal base member and a second surface open to the atmosphere, and said fixed case member has a large diameter portion, a small diameter portion, and an annular ledge portion having said large and small diameter portions integrally formed with each other to have the peripheral end portion of said metal base member mounted thereon and welded thereto, said small diameter portion having an open peripheral edge inwardly bent to be firmly engaged with said second surface of said cover member.

8. An acceleration sensor for detecting an acceleration as set forth in any one of the claims 1 through 7, in which said cover member is smaller in diameter than said metal base member to form an annular gap between the inner surface of said small diameter portion of said fixed case member and the outer peripheral end surface of said cover

member, and which further comprises a resilient ring disposed in said annular gap and rested on said metal base member to have said closed space hermetically sealed.

9. An acceleration sensor for detecting an acceleration as set forth in claim 8, in which said resilient ring is made of an O-ring.

10. An acceleration sensor for detecting an acceleration as set forth in any one of claims 1 through 9, in which said cover member is formed with a circular recess having said printed board received therein, and an annular groove open to said circular recess, said metal base member is formed with an annular projection extending through said printed board and snugly received in said annular groove of said cover member to have said cover member positioned with respect to said metal base member with said printed board positioned interposed between said cover member and said metal base member.

11. An acceleration sensor for detecting an acceleration as set forth in any one of claims 1 through 10, in which said fixed case member has a screw portion to be screwed to an exterior object which is to receive said acceleration.

12. An acceleration sensor for detecting an acceleration caused by an object oscillated in an oscillation direction, comprising:

a sensor casing having a center axis and to be positioned in coaxial alignment with said oscillation direction to receive said acceleration, said sensor casing including a cylindrical fixed case member having a supporting portion axially extending, and a cover assembly provided on said fixed case member to cover said fixed case member to define a closed space;

an oscillation plate accommodated in said closed space of said sensor casing and having a central portion supported by said supporting portion of said fixed case member, and a peripheral portion integrally formed with said central portion and extending radially outwardly of said central portion to be freely movable with respect to said supporting portion of said fixed case member, said oscillation plate being partly oscillatable along said center axis with respect to said fixed case member;

a piezoelectric element held in contact with said oscillation plate to generate a voltage indicative of said acceleration when said acceleration is exerted on said sensor casing to have said oscillation plate partly oscillated along said center axis with respect to said sensor casing with said peripheral portion of said oscillation plate being deformed, said piezoelectric element having first and second electrodes having said voltage indicative of said acceleration to output

therethrough, and said oscillation plate and said piezoelectric element being integrally oscillatable within a range of effective oscillation frequencies; and

at least one terminal pin extending through said cover assembly and terminating at the exterior of said cover assembly, said terminal pin electrically connected with one of said electrodes;

whereby said oscillation plate and said piezoelectric element are integrally oscillatable in two different modes consisting of: a first oscillation mode where said oscillation plate is irregularly deformed to have said peripheral portion oscillated with a single vector in said oscillation direction of said oscillation plate when said oscillation plate is oscillated with respect to said fixed case member at a resonance frequency f_0; and a second oscillation mode where said oscillation plate is irregularly deformed to have two different half parts of said peripheral portion oscillated with their respective different vectors opposite to each other in said oscillation direction of said oscillation plate when said oscillation plate is oscillated with respect to said fixed case member at a noise frequency f_01, and said resonance frequency f_0 and said frequency f_01 are out of said range of effective oscillation frequencies.

13. An acceleration sensor for detecting an acceleration as set forth in claim 12, in which said supporting portion of said fixed case member has a cylindrical section and a forward tapered section integrally formed with said cylindrical section and in the form of a truncated cone shape, said forward tapered section having a top surface securely held in contact with said second surface of said oscillation plate and having an outer end edge in axially alignment with the outer peripheral end of said peripheral portion of said oscillation plate, said outer end edge having a diameter ϕC_1 (mm), and said oscillation plate having an effective oscillation radius R_1 (mm) measured between the inner and outer ends of said peripheral portion of said oscillation plate;

whereby said oscillation plate and said piezoelectric element are integrally oscillatable in said first and second oscillation models with ϕC_1 (mm) / R_1 (mm) and f_01/f_0 given the following equations.

ϕC_1 (mm) / R_1 (mm) ≥ 0.92 and $f_01 / f_0 \geq 0.52$.

14. An acceleration sensor for detecting an acceleration as set forth in claim 12 or claim 13, in which said fixed case member and said oscillation plate are each made of an electroconductive material to ensure that the remaining one of said electrodes is electrically

connected with said oscillation plate and said fixed case member.

15. An acceleration sensor for detecting an acceleration caused by an object oscillated in an oscillation direction, comprising:

a sensor casing having a center axis and to be positioned in coaxial alignment with said oscillation direction to receive said acceleration, said sensor casing including a cylindrical fixed case member having a supporting portion axially extending, and a cover assembly provided on said fixed case member to cover said fixed case member to define a closed space;

an oscillation plate accommodated in said closed space of said sensor casing and having a central portion supported by said supporting portion of said fixed case member, and a peripheral portion integrally formed with said central portion and extending radially outwardly of said central portion to be freely moveable with respect to said supporting portion of said fixed case member, said oscillation plate being partly oscillatable along said center axis with respect to said fixed case member, said oscillation plate having a first flat surface opposing and spaced apart along said center axis with respect to said fixed case member, and a second flat surface opposing and spaced apart along said center axis with respect to said cover assembly of said sensor casing;

a first piezoelectric element having a first surface and a second surface, said first surface of said piezoelectric element held in contact with said second flat surface of said oscillation plate to generate a voltage indicative of said acceleration when said acceleration is exerted on said sensor casing to have said oscillation plate partly oscillated along said center axis with respect to said sensor casing with said peripheral portion of said oscillation plate being deformed;

a second piezoelectric element having a first surface and a second surface, said first surface of said second piezoelectric element held in contact with said first flat surface of said oscillation plate to generate a voltage indicative of said acceleration when said acceleration is exerted on said sensor casing to have said oscillation plate partly oscillated along said center axis with respect to said sensor casing with said peripheral portion of said oscillation plate being deformed, said first and second piezoelectric elements each having a plurality of electrodes having said voltage indicative of said acceleration to output therethrough, said electrodes including a first electrode provided on said second surface of said first piezoelectric element, and a second electrode provided on said second surface of said second piezoelectric

element, and a second electrode provided on said second surface of said second piezoelectric element, and said oscillation plate and said first and second piezoelectric elements being integrally oscillatable within a range of effective oscillation frequencies; and

at least one terminal pin extending through said cover assembly and terminating at the exterior of said cover assembly, said terminal pin electrically connected with said first and second electrodes;

whereby said oscillation plate and said first and second piezoelectric elements are integrally oscillatable in two different modes consisting of: a first oscillation mode where said oscillation plate is irregularly deformed to have said peripheral portion oscillated with a single vector in said oscillation direction of said oscillation plate when said oscillation plate is oscillated with respect to said fixed case member at a resonance frequency f_0; and a second oscillation mode where said oscillation plate is irregularly deformed to have two different half parts of said peripheral portion oscillated with their respective different vectors opposite to each other in said oscillation direction of said oscillation plate when said oscillation plate is oscillated with respect to said fixed case member at a noise frequency f_01 are out of said range of effective oscillation frequencies.

16. An acceleration sensor for detecting an acceleration as set forth in claim 15, in which said supporting portion of said fixed case member has a cylindrical section and a forward tapered section integrally formed with said cylindrical section and in the form of a truncated cone shape, said forward tapered section having a top surface securely held in contact with said second surface of said oscillation plate and having an outer end edge in axially alignment with the outer peripheral end of said peripheral portion of said oscillation plate, said outer end edge having a diameter ϕC_1 (mm), and said oscillation plate having an effective oscillation radius R_1 (mm) measured between the inner and outer ends of said peripheral portion of said oscillation plate;

whereby said oscillation plate and said first and second piezoelectric element are integrally oscillatable in said first and second oscillation modes with ϕC_1 (mm) / R_1 (mm) and f_01 / f_0 given in the following equations.

ϕC_1 (mm) / R_1 (mm) ≥ 0.92 and $f_01 / f_0 \geq 0.52$.

17. An acceleration sensor for detecting an acceleration as set forth in any one of claims 15 and 16, in which said first piezoelectric element having a third electrode provided on said first

surface of said first piezoelectric element, and second piezoelectric element having a fourth electrode provided on said second surface of said first piezoelectric element, and said fixed case member and said oscillation plate are each made of an electroconductive material and to ensure that said third electrode of first piezoelectric element and said fourth electrode of said second piezoelectric element are electrically connected with said oscillation plate and said fixed case member.